Eur J Vasc Endovasc Surg **30**, 534–538 (2005)
doi:10.1016/j.ejvs.2005.05.021, available online at http://www.sciencedirect.com on SCIENCE DIRECT®

Popliteal Aneurysms: Distortion and Size Related to Symptoms

R.B. Galland* **and T.R. Magee**

Department of General Surgery, Royal Berkshire Hospital, Reading, UK

Objectives. *To examine size and distortion of popliteal aneurysms (PA) in relation to symptoms produced at presentation.*
Methods. *A prospective study of all PA presenting to a single unit 1988–1994. Wherever possible patients underwent angiography, duplex scanning and measurement of both PA diameter and the most proximal angle of distortion. Symptoms and measurements were noted at the time of first presentation.*
Results. *Seventy-three patients presented with 116 PA. At initial diagnosis 44 PA (38%) were asymptomatic and 39 (34%) produced acute ischaemia. As the PA increased in diameter so did the degree of distortion ($p < 0.0001$). Size and distortion were greater in PA producing acute ischaemia or acute thrombosis than in asymptomatic PA ($p < 0.01$). Degree of distortion differentiated symptomatic from asymptomatic PA ($p = 0.0066$). Size was not significantly different between these two groups. For PA 3 cm or larger in diameter with greater than 45° distortion sensitivity, specificity and positive and negative predictive values for thrombosis were 90, 89, 83 and 94%, respectively.*
Conclusion. *Distortion and size can differentiate between PA producing different symptoms. Combining the two provides a reliable method of differentiating PA which should be managed by early elective repair.*

Keywords: Popliteal aneurysms; Distortion; Size; Symptoms.

Introduction

Approximately 14% (range 5–24%) of asymptomatic popliteal aneurysms (PA) develop symptoms each year.[1] Acute limb ischaemia is present in approximately one third of patients whose PAs require operation.[2–8] Other symptoms include intermittent claudication, pressure symptoms in the popliteal fossa, distal embolisation and rarely rupture. An analysis of recent studies suggests that 25–80% of PA are asymptomatic at the time of operation.[2–8]

PA tend to occur in older men with significant comorbidity and a life expectancy of about 60% at 5 years.[1] Elective repair of asymptomatic PA is not without risk. Death and limb loss are both reported and about 1% of patients will be left with residual symptoms. Inevitably, patients will be made worse in the short term by having surgical treatment of an asymptomatic condition. Using a Markov decision analysis we calculated that at the average rate of developing symptoms of 14% per year it was 16 months before a break-even point was reached such that the patient benefited from operation.[1] Identifying high risk aneurysms would shorten this break-even point.

Diameter of PA does seem to relate to symptoms. In a multicentre study of 200 PA[9] asymptomatic aneurysms were on average 2 cm in diameter and PA with limb threatening ischaemia 3 cm. However, there is very little evidence to suggest that once a PA has reached 2 cm in diameter elective repair should be considered. Nevertheless 2 cm is often taken as a cut off point for elective repair.

Similarly, it is often stated that thrombus within a PA is an indication for elective repair. Ultrasound examination does suggest that approximately three quarters of PA will contain thrombus.[9] PA with thrombus are significantly larger than those without. However, there is no evidence that the presence of thrombus is an independent risk factor for subsequent aneurysm thrombosis.

One retrospective study showed a greater risk of complications in PA associated with absent distal pulses compared with those with distal pulses.[10]

*Corresponding author. Mr R.B. Galland, MD, FRCS, Consultant Surgeon, Royal Berkshire Hospital, London Road, Reading RG1 5AN, UK.
E-mail address: robert.galland@rbbh-tr.nhs.uk

1078–5884/000534 + 05 $35.00/0

That apart there is little evidence to support the fact that poor run off, perhaps being due to embolisation, is an indication for elective repair.

As the popliteal artery dilates it also lengthens. Since, the upper and lower ends of the artery are relatively fixed the aneurysm becomes distorted. The combination of distortion and diameter greater than 3 cm was present in 13 of 15 thrombosed aneurysms which we described in 1993.[11] The aim of this paper is to examine size and distortion of popliteal aneurysms in relation to symptoms produced at initial presentation.

Methods

Between January 1988 and December 2004 all patients presenting with popliteal aneurysms were prospectively studied. Patients, when feasible, underwent angiography (digital subtraction or magnetic resonance) and duplex scanning of their aneurysms. In addition to measuring PA diameter the degree of distortion was also measured whenever possible. This applied to patent aneurysms and patients with thrombosed PA which had been cleared or partly cleared with thrombolysis. In our unit, patients with thrombosed PA were treated by intra-arterial thrombolysis between November 1988 and September 1992. At that point we abandoned the technique due to the unacceptably high level of complications.[12] Fig. 1 shows an angiogram of a popliteal aneurysm with considerable distortion. The most proximal angle of distortion (*a*) was measured with the angiogram in antero-posterior plane. Data on morphology were not available for all PA.

Symptoms and measurements were all taken from the time at which the patient first presented. Statistical analysis was carried out using a Mann–Whitney *U*-test, χ^2 test and linear regression analysis as appropriate. Statistical significance was taken at $p<0.05$. Sensitivity was defined as being the proportion of positives correctly identified by the cut off points set. Specificity was the proportion of negatives correctly identified, positive predictive value the proportion with a positive result correctly identified and negative predictive value the proportion with a negative result correctly identified.

Results

Seventy-three patients presented with 116 PA, bilateral PA being present in 43 patients (59%). There were 71 men and two women. The median age was 69 years (46–89).

Fig. 1. Thrombosed PA partially cleared by thrombolysis. Distortion is shown. The most proximal angle of distortion (*a*) was measured.

Risk factors included hypertension (32), ischaemic heart disease (19), cerebrovascular accident (12), diabetes (5) and other significant comorbidity in 31. At the time of presentation 33 patients still smoked. Thirty-six patients (49%) has coexisting abdominal

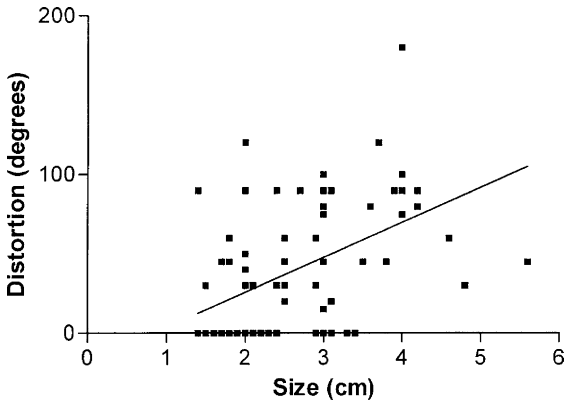

Fig. 2. Distortion and size for all PA with complete data.

aortic aneurysms (AAA), five had iliac and six femoral aneurysms. Some 45 patients presented with a thrombosed PA. In 31 of these cases the aneurysms were bilateral. Only 12 of the 28 patients who did not present with a thrombosed PA had bilateral aneurysms (χ^2 4.83, df 1, $p<0.03$).

At the time of initial diagnosis 44 (38%) PA were asymptomatic, 39 (34%) produced acute ischaemia (thrombosis 31, embolus eight), 29 (25%) intermittent claudication (thrombosed 16, patent 13) and four (3.4%) were producing pressure symptoms in the popliteal fossa. No patient presented with a ruptured PA, though one did rupture when a patient was being treated with heparin for thrombosed PA on the other side.[13] Fig. 2 shows that as the aneurysm increases in diameter the degree of distortion also increases ($p<$ 0.0001).

The relationship between size and distortion and symptoms at presentation is shown in Table 1. Both size and distortion were greater in PA producing acute ischaemia or acute thrombosis than asymptomatic PA. On the other hand although symptomatic PA were larger than aymptomatic aneurysms this was not statistically significant. Distortion was significantly greater in symptomatic compared with asymptomatic PA.

With regard to thrombosed PA, those producing acute ischaemia were significantly larger than those producing intermittent claudication. The degree of distortion between those two groups was not significantly different. The largest PA were not surprisingly those producing pressure symptoms in the popliteal fossa.

Data on size were available on 44 thrombosed PA. Of those producing acute ischaemia or intermittent claudication five of 28 and seven of 16, respectively, were below 2 cm in diameter. Distortion below 45° was only present in three of 21 thrombosed PA (two of 15 with acute ischaemia and one of six with intermittent claudication). Fig. 3 shows thrombosed PA with complete data regarding both size and distortion. The combination of distortion below 45° and size less than 3 cm was only present in two of 21 PA.

The highest sensitivity, specificity and positive and negative predictive values comparing thrombosed with asymptomatic PA were obtained when selecting PA 3 cm or greater in diameter with 45° distortion or greater (Table 2). All of the four patent PA at presentation within this group thrombosed before surgical repair could be undertaken. Correcting for these cases results in sensitivity, specificity and positive and negative predictive values for this group of PA to be even higher at 92, 100, 100 and 94%, respectively.

Discussion

These results confirm that as the popliteal aneurysm increases in diameter so does the degree of distortion increase. Differences in PA morphology determined by size and distortion were associated with differences in

Table 1. Symptoms produced related to size and distortion

	Size (cm)		Distortion (°)	
	Median (range)	*p* Value	Median (range)	*p* Value
Symptomatic:asymptomatic	2.4 (0–5.6):2.0 (1.5–4.8)	0.2083	45 (0–180):0 (0–90)	0.0066
Acute ischaemia:asymptomatic	3.0 (0–4.6):2.0 (1.5–4.8)	0.0021	60 (0–180):0 (0–90)	0.0012
Acute thrombosis:asymptomatic	3.0 (1.5–4.6):2.0 (1.5–4.8)	0.0018	60 (0–120):0 (0–90)	0.004
Thrombosed:non-thrombosed	2.5 (1.4–4.6):2.0 (0–5.6)	0.1373	60 (0–180):0 (0–120)	0.0028
Thrombosed				
Acute ischaemia:IC	3.0 (1.5–4.6):2.0 (1.4–3.6)	0.0037	60 (0–120):45 (0–90)	0.3082
Patent				
IC:asymptomatic	2.0 (2–3.0):2 (1.5–4.8)	0.3411	0 (0–120):0 (0–90)	0.5613
Acute embolus:asymptomatic	2.9 (1.7–4.0):2.0 (1.5–4.8)	0.0575	70 (0–180):0 (0–90)	0.0356
Compression:asymptomatic	3.45 (3–5.6):2.0 (1.5–4.8)	0.0045	45 (45–90):0 (0–90)	0.0169
IC:acute embolus	2 (2–3.0):2.9 (1.7–4.0)	0.0463	0 (0–120):70 (0–180)	0.1406
IC:compression	2 (2–3.0):3.45 (3–5.6)	0.0055	0 (0–120):45 (45–90)	0.1455

IC, intermittent claudication.

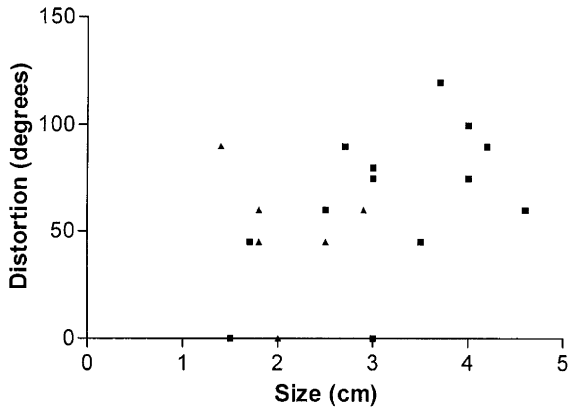

Fig. 3. Distortion and size for thrombosed PA with complete data. ■, acute ischaemia; ▲, intermittent claudication.

symptoms produced. Although our analysis is based on ultrasound and IV or MR angiography there is no reason why newer imaging modalities, such as CT multislices with 3-D reconstruction could not be used to provide similar information. The decision to operate electively on an asymptomatic PA is based on the likelihood of limb-threatening ischaemia developing. This needs to be set against the fact that the leg will be made worse in the short term. Operating on high risk PA will shorten the break-even point at which operation becomes beneficial.[1]

The presence of thrombus within a PA, poor run off and diameter greater than 2 cm have all been suggested as ways of identifying high risk patients. There is little evidence to support any of these suggestions. As a popliteal aneurysm becomes larger thrombus develops within it.[9] The presence of thrombus itself does not seem to be an independent risk factor for thrombosis. The suggestion that thrombus within the aneurysm may produce micro emboli which in turn slowly obliterates distal run off, may be correct but there is no evidence to support it. Symptoms are more likely with larger aneurysms. However, there is little hard evidence to suggest that once an aneurysm reaches 2 cm in diameter elective operation should be advised.

Our results confirm that asymptomatic aneurysms had a median diameter of 2 cm compared with 2.4 cm for those which were symptomatic. This difference was not statistically significant. However, both aneurysms producing acute ischaemia and those producing acute thrombosis had a median diameter of 3 cm which was significantly larger than asymptomatic aneurysms. Aneurysms producing compression within the popliteal fossa comprised the largest group of aneurysms as a mean diameter of 3.45 cm.

PA that were symptomatic showed significantly greater distortion than asymptomatic PA. Similarly, degree of distortion differentiated between PA which produced acute ischaemia (due to thrombosis or embolus) and asymptomatic aneurysms and between thrombosed and non-thrombosed PA. When considering features which might predict thrombosis size alone was not particularly useful. Diameter greater than 2 cm, the often quoted cut off point for advising elective repair only had a sensitivity of 73% and specificity of 39%. These figures were slightly better at 86 and 82%, respectively, when considering PA with

Table 2. Sensitivity, specificity, positive and negative predictive values related to size and distortion for thrombosed and asymptomatic popliteal aneurysms

	Thrombosed	Asymptomatic	Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Negative predictive value (%)
Less than 2 cm diameter	12/44	17/44	73	39	54	59
2 cm diameter or greater	32/44	27/44				
Less than 3 cm diameter	27/44	35/44	39	80	65	56
3 cm diameter or greater	17/44	9/44				
Less than 45° distortion	3/21	31/38	86	82	72	91
45° distortion or greater	18/21	7/38				
Less than 3 cm diameter and less than 45° distortion	2/21	34/38	90	89	83	94
3 cm diameter or greater and 45° distortion or greater	19/21	4/38				

The denominators show how many PA had ultrasounds (for size) or angiograms showing full morphology.

distortion greater than 45°. However, combining diameter more than 3 cm with greater than 45° distortion produced the best discrimination. Positive and negative predictive values for thrombosis being 83 and 94%, respectively. These figures underestimate the predictive value as the four PA in this group which were patent at presentation all thrombosed before operation could be carried out.

Finally, is it safe to observe PA less than 3 cm diameter with no significant distortion? We have adopted this policy since January 1993.[12] Of 17 PA 2–3 cm diameter, which would have undergone elective repair if a 2 cm cut off were advised, none have thrombosed at a median follow up of 26 months (unpublished data). Four patients did develop symptoms, comprising discomfort behind the knee and underwent successful elective repair. On the other hand of seven PA > 3 cm in diameter in patients who were unfit or unwilling to have an operation, three thrombosed and all became symptomatic.[12] All of the four patent PA at presentation greater than 3 cm in diameter with greater than 45° distortion thrombosed within a short time of presentation before elective repair could be undertaken.

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Accepted 20 May 2005
Available online 11 July 2005